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FINAL REPORT

(U) CONTROLLED RANGE NETWORK

SPECIAL ACCESS REQUIRED

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(U) CONTROLLED RANGE NETWORK

by

[redacted] 25X1

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December 1970

SPECIAL ACCESS REQUIRED

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Prepared For

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Directorate of Reconnaissance Engineering
Deputy For Engineering
Aeronautical Systems Division
Air Force Systems Command
Wright-Patterson Air Force Base, Ohio

[redacted]

70-DC-176-3

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FOREWORD

This report describes services provided by [redacted] in compliance with the requirements of [redacted] as specified in its accompanying statement of work. 25X1 25X1

The contract began on 1 October 1969 and extended through 30 September 1970. [redacted] Directorate of Reconnaissance Engineering (ASD/ENRDP), Wright-Patterson Air Force Base, Ohio was the Air Force Program Manager and [redacted] was his alternate. 25X1 25X1

A number of the technical staff of [redacted] provided services on this contract. Principal personnel engaged in this project included [redacted] and the author. 25X1 25X1 25X1

The manuscript of this report was submitted by the author for initial review on 19 October 1970. It is identified by the contractor's file number FR-70-4.

This final report has been reviewed and is approved.

[redacted] 25X1

Project Manager
Directorate of Reconnaissance Engineering

UNCLASSIFIED ABSTRACT

This report summarizes activity related to the operation of the Controlled Range Network during the period of 1 October 1969 to 30 September 1970. This final report presents a resume of services provided for the United States Air Force by [redacted] 25X1 25X1 in response to the requirements of [redacted] 25X1 The procedures used to provide target service, preparation of related publications, scope of collateral services, and certain related research efforts are described.

CONTENTS

SECTION I

INTRODUCTION

Advances in reconnaissance technology are greatly dependent upon the capability to measure accurately the performance of individual sensors and sensor systems. Extensive laboratory tests are performed on these reconnaissance components and sensor systems; however, the most realistic evaluation is achieved during actual flight testing under operational conditions.

This method of evaluation requires accurate mensuration standards and instrumentation to support system evaluation. It is also highly desirable to standardize the analysis techniques and mensuration standards throughout the reconnaissance community. This provides not only for repeatability of testing conditions, but also for comparison of various systems.

A number of ground evaluation standards, together with their related analysis techniques, have been designed for the purpose of providing a basic capability to support the development and evaluation of photographic, [redacted] 25X1

This array of ground targets and associated instrumentation capability, together with the experienced technical personnel to operate them effectively, comprise the Controlled Range Network (CORN).

The resources of the Controlled Range Network are available on a nationwide basis to members of the reconnaissance community. Any customer, through a simplified communication channel, can be provided with an array of evaluation standards and meaningful photometric and atmospheric instrumentation data with which to analyze the overall performance of a system.

25X1 This final report presents a summary of CORN activity provided for the United States Air Force by [redacted] during the contract period.

SECTION II

TECHNICAL DISCUSSION

A. GENERAL

The Controlled Range Network is operated by [redacted] from its principal facility at [redacted] Personnel in the [redacted] office manage all aspects of the operation of the network and provide a variety of supporting services. 25X1 25X1

The principal area of endeavor is targeting and instrumentation service. This is provided by one crew based in [redacted] and by eight other field crews located across the nation. 25X1

Supporting services include certain research efforts, material procurement for special projects, an overall quality control program, maintenance of a multisensor test capability, and publication of handbooks.

B. FIELD OPERATIONS

Targeting service is provided on a nationwide basis by nine target crews. Each crew is provided with a specified group of targets and supporting instrumentation so that, when required, a series of nine similar target groupings can be displayed. Instrumentation can be provided concurrently at fixed sites, as required. When the scope of operations requires it, a second crew equipped with the standard set of targets and instrumentation can be made available from [redacted] resources. 25X1

The target set, instrumentation, and crew are transported from the operating base to the display site by a heavy-duty truck which is especially configured to accommodate both crew and equipment. Communications from [redacted] to each operating base are by teletype. 25X1

The nine operating bases are located at cities as shown in Figure 1. When a target display is required, the crew nearest the requested site is directed to display the targets.

During the past year, one field crew was relocated from [redacted] 25X1

[redacted] Crew performance at [redacted] had become unacceptable in terms of quality. 25X1

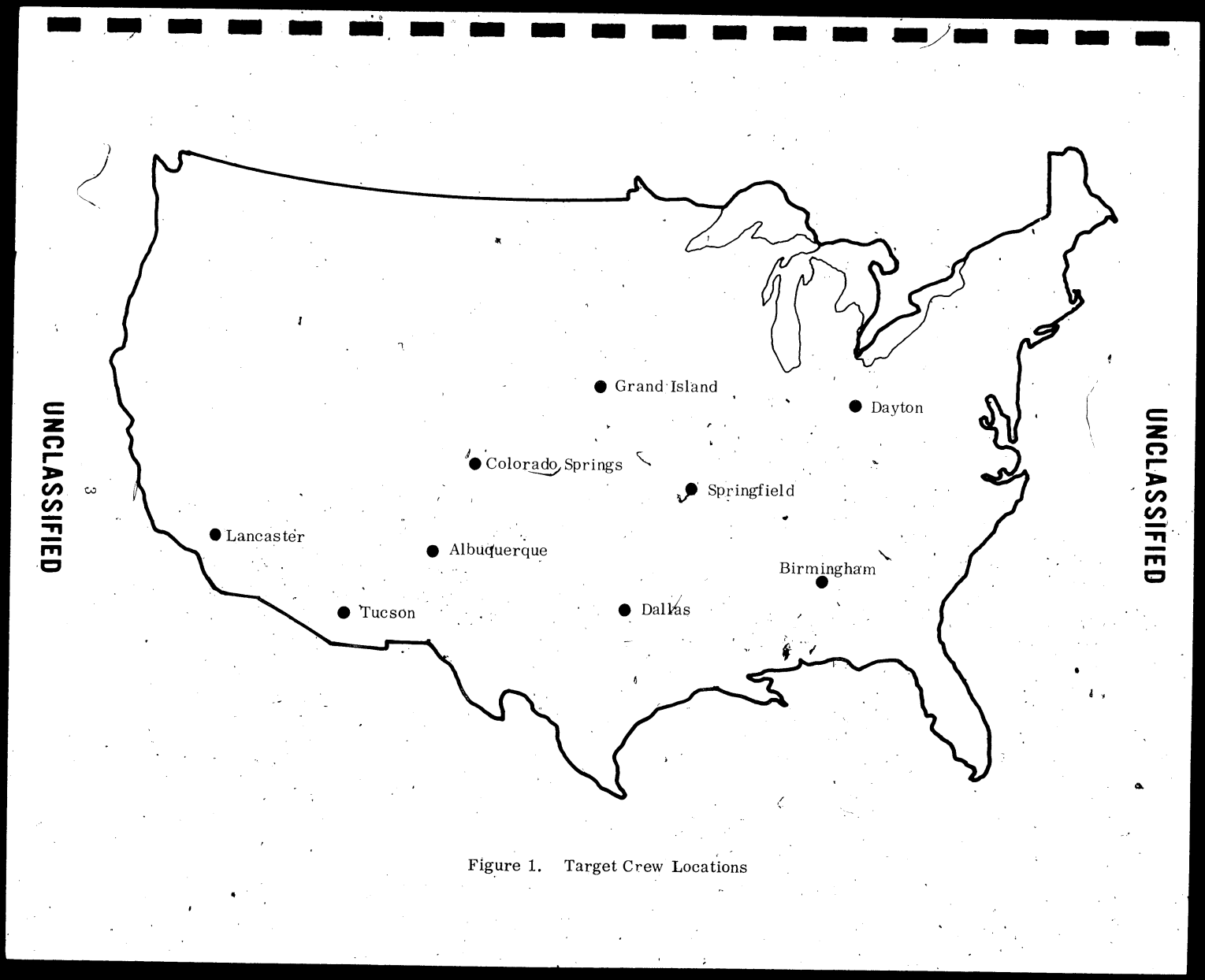

Figure 1. Target Crew Locations

Historically, the pattern of requested display locations changes and future distribution may not be entirely predictable. Operating experience indicates that these locations are satisfactory, considering both the geographical distribution and the sequence of displays in given CORN operations. The expense incurred in the selection and training of new CORN target crews, as well as a reduction in initial proficiency during the transition period, is significant. Thus, in the interest of overall economy, relocation of the field crew is done only for most compelling reasons.

Such a magnitude of field operations requires a proportional amount of supporting services by the [redacted] 25X1

To assure that the basic set of data is most meaningful, the targets and associated instrumentation employed in the field must be maintained at a uniform level of quality. Spectral characteristics of representative samples of each reflectance area of each target are measured bimonthly. Samples are measured on a single-beam recording spectrophotometer at [redacted] 25X1

Each 70 mm Hasselblad camera is recalled from the field and recalibrated at intervals of 180 days. This calibration process is accomplished by [redacted] 25X1 technicians using both in-plant test equipment and certain specialized items of calibration equipment in the Avionics Laboratory at Wright-Patterson Air Force Base.

Energy-measurement equipment (such as radiometers, light meters, and brightness meters) is calibrated at intervals of 45 to 90 days.

If any instrumentation component malfunctions in the field, it is immediately recalled to [redacted] 25X1 for repair and recalibration; it is replaced with a similar unit which has been recently certified.

In addition to these mechanical functions, there are other aspects of the operation in which quality is constantly monitored. Emphasis is placed on quality of target displays, field operations, and related operational procedures in field exercises.

Technicians from [redacted] 25X1 who are thoroughly experienced in every aspect of the field operation, make unannounced inspections at a number of target

display sites during field operations. This helps to assure that the targets are displayed correctly and that the procedures for data collection used by the field crews are correct.

(U) Continued emphasis on quality during the past year has produced the expected improvement in overall operational effectiveness. Greater demand for field-crew proficiency has, in turn, resulted in a general growth of quality in target displays and the raw data collected during operations.

(C) Quality of Hasselblad edge-target photography is cited as a specific example. Contrast data derived from this photography correlated extremely well with similar data derived from spectrophotometric measurements of target specimens made under laboratory conditions. Because of this correlation and for reasons of economy and variables in the field environment, edge photography was discontinued on Program C operations. Because of other requirements, however, this type of photography was retained on Program B operations.

(U) Except for a very small number of human errors, the overall quality of target displays has continued to be high.

(U) Shortly after the contract term began, it was recommended that a number of the older targets be replaced. After some deliberation, the formal contract amendment was issued in July.

(U) This amendment authorized procurement of six photographic edge-analysis targets, two tricolor targets, and two 51/51 resolution targets. One [redacted] 25X1
25X1 and one [redacted] target were authorized to replace one of the two unserviceable sets of similar targets in the mobile multisensor units.

25X1 (U) Except for the [redacted] all of the newly acquired targets were fabricated from a lightweight nylon base material which had previously been qualified for this application through actual field use. Previously, two edge-analysis targets, as well as the Dirac comb and the two-dimensional (annular) MTF targets, were fabricated from this material. They had been used extensively in field operations during the previous 18 months and have proved to be most satisfactory. In addition to the light weight, the

dimensional stability and durability of both the base material and the spectral coating have been proven superior to the materials previously used.

C. COLLATERAL SERVICES

1. Handbooks: The condition and general capabilities of test ranges, fixed targets and other test facilities available for reconnaissance system testing throughout the nation are monitored and reported in the CORN target handbook. This handbook is distributed on a limited basis.

The CORN handbook was completely revised in 1968. During this contract term, one major revision was published; a second was in preparation at the end of the contract term.

A related publication, the Handbook of Standard Operating Procedures for the Controlled Range Network, specifies operational procedures for field work. This publication is distributed only to those groups who are concerned with the mechanics of the display and operation. There have been a number of revisions made to this handbook due to the numerous operational changes which have occurred during the past year.

2. Reports: Monthly reports are prepared and submitted in accordance with the requirements of the DD Form 1423. These reports summarize operational and support activity which has occurred during the reporting period. Each monthly report also contains an expanded section which itemizes fund expenditures on the contract in several major cost categories.

Operational reports are prepared and submitted within five working days following each field operation. Original reports from the field crew at each display site are analyzed, collated, and submitted with raw data collected during the display at each operating location.

A final report which summarizes the variety of activity which occurred during the contract term, including certain recommendations, is prepared and submitted at the end of the contract term.

3. Special Projects: Resources of the Controlled Range Network are made available to fulfill requirements of special projects, after proper authorization. These projects vary greatly in number, scope, duration, and geographic location. Because of these gross variables, each of these special projects is authorized, identified, and reported separately from normal CORN operations. Also, the extent of the variables precludes specific consideration in defining the scope of the CORN program at the beginning of the contract term.

In the twelve-month period covered by this contract, there were three major special projects for which CORN support was directed. Two of these were part of one larger program and the third was an interservice program. Each, however, was funded from basic CORN contract resources and was a direct factor in the expenditures, which exceeded original contract-funding estimates. Requirements for these three projects included the acquisition by [redacted] of aerial photography over a number of widely separated sites, in addition to making standard target displays and providing instrumentation and other data-gathering services. 25X1

4. Special Research: A major endeavor associated with this contract, but defined and funded separately, is a research function. Work done in this area is reported separately.

5. Disposable Targets: Development of prototype disposable-target ensembles, which was started as a supplementary task during the previous contract, extended into a part of this contract term. An infrared T-type resolution target with a series of three-bar groups and an edge-analysis target were designed, fabricated, and deployed on a trial basis. These were fabricated from a disposable paper base and are intended to provide an evaluation standard for airborne infrared ground-mapping systems. Encouraging results were obtained during a limited number of tests. There was a direct correlation between the size of the bar group observed and the resolution statement derived from the edge target.

6. Mobile Multisensor Units: Two mobile multisensor units were maintained in an operationally ready, standby status. The multisensor unit is a vehicle which is equipped with specially designed targets and instrumentation to provide evalu-

ation standards and basic data for the operational testing and evaluation of airborne reconnaissance systems.

Facilities are provided to support the testing of infrared ground-mapping systems and [redacted] systems as well as photographic and [redacted] 25X1 These mobile multisensor units can be made available for extended periods of use within the structure of the requester's test program.

Although there was marked reduction in available funding to provide [redacted] 25X1 services, the demand continued at a high level. This demand was evidenced by the frequent requests and inquiries by testing groups which were received throughout the past twelve months. However, there was one major separately funded and authorized [redacted] program which required 17 separate displays over an eight-month period.

To accommodate the evident need, the [redacted] were utilized for 25X1 a number of short-term tests at Wright-Patterson Air Force Base. This support was provided on a basis of noninterference with the CORN program during periods when CORN resources could be utilized efficiently.

Types of sensors employed in these local tests encompass the spectrum of those now operationally available. Included were [redacted] as well as photographic, low light-level television, and laser-scanning devices. In the overall view, the benefit derived by the Air Force from such local support services is considered significant and certainly worthwhile. 25X1

SECTION III

OPERATIONS ANALYSIS

(C) Despite predictions to the contrary, the number of field operations as well as the number of individual target displays during this twelve-month period remained essentially at the level of the prior twelve-month period. An analysis of total target displays requested during this period is shown in Figure 2. (Had not one entire operation been suspended, the totals for the two periods would have been nearly identical.) Analysis of target display time is shown in Figure 3.

(C) Of the total requested, 84.2% were completed, 7.7% were not completed due to inclement weather, and 6.5% were cancelled by the requester. Other miscellaneous factors prevented completion of 1.6% of the requested displays.

(C) By comparison, during the twelve months which preceded the period of this report, 71.9% of the requested displays were completed, 14.4% were not made due to weather factors, and 8.5% were cancelled by the requester.

(U) The increase in completed displays is attributable in part to the continuing efficient communications between the requesting agency and the contractor's operating group. The mutual recognition of circumstances which influence operations is a significant factor in the rise of this percentage. More importantly, this probably also led to a rise in data which were acquired from the targets.

(U) Operational procedures during this twelve-month period have been changed, modified, and adapted to meet requirements which evolve as a result of the dynamic nature of the CORN program.

(C) A revised C Program, implemented in October, required the deployment of a number of resolution targets in a variety of contrasts. This required a redistribution of a few CORN targets, but otherwise created no significant problem. The revised program continued until June, when the requirement reverted to the standard Program C display.

TOTAL CORN DISPLAYS REQUESTED 1 October 1969 - 30 September 1970	TYPE	TOTAL DISPLAYS REQUESTED	CANCELLED DISPLAYS	CANCELLATION CAUSES								
				RAIN	SNOW	WIND	TRUCK BREAKDOWN	NO SITE AVAILABLE	BY REQUESTER	EVICTED FROM SITE	STANDING WATER	
October	C	12	4	1					3			
November	C	18	2		2							
	S	6	2	1					1			
December	B	13	3	1	2							
		3										
January	C	41	12	2	6				4			
	S	4	2						2			
February	S	1										
March	B	12	2						2			
	S	5	1						1			
April	C	36	4	2		1	1					
	S	1										
May	B	3										
June	C	12	1						1			
	B	6	1							1		
July	C	15	3						3			
	B	10										
August	C	30										
	S	2	1				1					
September	C	15	1					1				
TOTAL		245	39	7	10	1	2	1	16	1		

(U) Figure 2. Analysis of Target Displays

DISPLAY TIME

1 October 1969 - 30 September 1970

Total Displays with Crews in the Field

	0600-0700	0700-0800	0800-0900	0900-1000	1000-later	Total	
October					9	12	
November					24	24	
December					16	16	
January					45	45	
February					1	1	
March					17	17	
April		18	19			37	
May					3	3	
June		6		3	9	18	
July		17			8	25	
August		6	21		5	32	
September			15			15	
TOTAL		50	55	3	137	245	

(U) Figure 3. Analysis of Display Time

Hasselblad photography of edge-target components was discontinued on Program C operations in June. It was concluded, on the basis of an experiment, that there was extremely close correlation between contrast data derived from this photography and from spectrophotometric measurements of target specimens. The latter technique provides data acquired under controlled conditions and free from the variables encountered in the field environment. The Hasselblad photography was discontinued because of this correlation, as well as for reasons of economy.

High-reflectance impulse lines have been displayed on the dark portion of the edge-analysis target for both Program B and C operations. Width of the impulse lines has changed as the analysis technique developed.

The change which has had the greatest impact on field operations occurred in June. The long-range forecast of target display areas which had been successfully used was replaced with a short-term, 48-hour prediction. Display areas are identified by a grid system. This short-term period prediction does not permit the more efficient sequential scheduling of field crews for a larger segment of the operation. There may also be an effect on related costs. While it is a workable accommodation, the net effect will have to be assessed on a long-term basis.

SECTION IV

CONCLUSIONS

1. A number of significant operational benefits result from the use of the lightweight nylon as base material for CORN targets. Useful life of these targets can be extended, and both display quality and (in all likelihood) quality of data acquired will improve. Further, it is possible that some savings in field operations can be realized from use of these targets.

2. Based upon the ratio of completed to requested displays, the overall efficiency of CORN field operations has improved over the previous twelve-month period.

3. The short-term operational prediction of display sites imposes restraints which may have adverse effects on the efficiency of the overall operation.

SECTION V

RECOMMENDATIONS

1. The number of inquiries about the mobile [redacted] capability and the availability of these units indicates a continuing strong demand. The present mobile [redacted] units and the unique evaluation capabilities which they provide should continue to be maintained in a standby status and made available for those requesters who can utilize them. 25X1 25X1 25X1

2. A wide continuing interest in the test facility descriptions contained in the CORN target handbook has been expressed by numerous government test agencies. It is recommended that this publication be made available for broader distribution. The handbook is unclassified and additional copies can be made available with little effort. The modest cost would be greatly offset by the benefit derived from government testing agencies.

3. Standard targets which are procured for future CORN requirements should be fabricated from the lightweight base material until a better material is developed and qualified for this purpose.

4. If at all possible, the operational forecast information for CORN programs should be extended to at least 96 hours in advance of the display instead of the present 48-hour notice. This would permit more efficient scheduling of field crews.